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REPORT

The ISShango project

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1. Introduction

The Ishango rod is a 22,000-year-old bone that was found in Ishango, an area situated on the border of the Congo and Uganda close to Rwanda. It was transported in colonial times from the Congo to Belgium. The purpose of the ISShango project is to realize the metaphor from the well known opening sequence of Kubrick's film *2001: A Space Odyssey* and to establish a temporary 6-month 'mathematical art exposition' in space featuring the Ishango rod. If approved, it could be timed to coincide with the next 6-month mission to the International Space Station (ISS) by a Belgian astronaut, tentatively planned for 2009.

2. Historical and mathematical background

The Ishango rod is an artefact that was found near a Congolese village called Ishango by the Belgian archaeologist Jean de Heinzelin de Braucourt (see Figure 1). This occurred more than 50 years ago when the Democratic Republic of Congo was a Belgian colony. The discoverer brought the petrified bone to the Royal Museum for Natural Sciences of Belgium (RBINS) in Brussels where it has remained ever since [8,9].

The rod has three columns of clearly distinguishable fine, sharp groups of carvings (see Figure 2). One column shows scratches in the following order: 3, 6; 4, 8; 10, 5; 5, 7. These numbers sum to 48. The first two pairs could indicate the operation of doubling. The other two columns show the groupings 11, 21, 19, 9 and 11, 13, 17, 19 respectively; that is $10+1$, $20+1$, $20-1$, $10-1$ and the prime numbers between 10 and 20. In his report on the excavations at Ishango, de Heinzelin advanced the hypothesis that the rod was evidence of some kind of arithmetical game, and he would later reiterate this in his widely-read 1962 Scientific American article [9].

Several years later, an American archaeologist, Alexander Marshack, would attach greater significance to the fact that the sum of the last two columns is 60, which he interpreted as the number of days in two months [19]. In his opinion, the first column sum 48 therefore corresponded to one-and-a-half months. Thus, stated Marshack, the rod should be seen as an astronomical calendar. Despite the unknown but undeniably mysterious logic behind the carvings, the rod remained for a long time nothing more than an isolated and singular artefact from the heart of Africa. For half a century it was kept on the 19th floor of the museum, out of sight of the regular museum visitor.

This oversight can be partially explained because the artefact was so unique. Furthermore, there had been discussion among archaeologists about the age of the rod. At the time of its discovery in the 1950s, there were no reliable tables for the Carbon-14 dating of objects from volcanic regions. To make a long story short, the matter has now been settled, and at least four different dating methods confirm that the Ishango rod is at least 22,000 years old. For some, this would push back in time by at least 15,000 years the dawning of mathematics, previously supposed to lie in Greece or Egypt.

Our knowledge of African mathematics has increased greatly since the 1950s thanks to the work of Ascher [1], Crowe [7], Gerdes [13], Joseph [16], Nelson et al. [21], and Zaslavsky [28]. The classical objection to the hypothesis about the mathematical nature of the Ishango rod is the absence of any writing on it, which to some seems indispensable for 'mathematical' reasoning. However, a report about an African counting genius [12] who had acquired his knowledge before arriving in the US as a slave, or examples of African board games such as *awari* [25], *boa* [14], *igisoro* [6], *kubuguza* [20], or *omweso* [23] that continued to be played even in modern times, proves

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Figure 1. A view on the Ishango 'Mountains of the Moon' (left) and Jean de Heinzelin in colonial times (right), showing the excavation site. © RBINS. Reprinted with permission.

the opposite [2]. It is interesting to note that these board games are clever games indeed, and a game of this type known as *bantumi* was recently implemented for the Nokia 3310 cell phone. Further, many different mathematical notational methods involving ropes, wooden sticks, and bones existed in Africa as well, and although such objects are very seldom exhibited in museums [17], missionary reports described their use and some do bear markings similar to those on the Ishango rod.

The emerging discipline of 'ethno-mathematics' has also established African creativity in counting systems. For instance, 'eight' is often expressed as 'four-four' and some African peoples say 'five-twelve' instead of 'seventeen' because they are using base 12, not 10. When they count using base 12, to indicate the digits of this base, they use their thumb to point successively to the 12 phalanxes of the four remaining fingers on the same hand. The sums $48 = 4 \times 12$ and $60 = 5 \times 12$ may thus have a purely arithmetical origin (similar to the preference to buy goods by dozens). These observations support the claim that the Ishango rod markings may indicate counting in a different base such as 12. Equally common in Africa is the attribution of mathematical significance to etched lines: etching schemes in the sand and on clothing show an abundance of structural characteristics, which to some mathematicians signify abstract graphs or geometric entertainments using elementary figures or fractal structures.

A question that remains open is the significance of the 'prime numbers' on the Ishango rod. There is evidence within Africa for complex kinds of calculations. Yoruba base 20 multiplication [10] shows that base 10 is not indispensable for performing difficult calculations. Similarly, the 'Ethiopian' multiplication system using only doubling and halving could explain the presence of the doublings on the Ishango rod. Unfortunately, no prime numbers have been recorded elsewhere in Africa.

In view of the above, V. Pletser, a researcher at the European Space Agency, defends a third less-spectacular hypothesis that the Ishango rod is simply a witness to a people counting in base 6 or 12 [24]. They may have grouped the lines following the pronunciation of their numbers, just as today grouping by fives or by twos is common in Western counting practices.

Whatever the true interpretation may be, there is some undeniable logic behind the markings on the rod. Of course, it is still too big a step to deduce that this tiny rod may have had any influence on, say Egypt and ancient Greece [18], [22], [27]. Scientists never state matters as certainly as the broad audience would like them to and indeed, some modesty is appropriate here, as pointed out in the *The Skeptical Inquirer* [26]. However, others have gone even further regarding claims about the existence of ancient mathematical artefacts. They point to a scratched fibula of a baboon found during excavations in caves in the Lebombo Mountains on the border between South Africa and Swaziland [3]. This 7.7 cm-long bone is 35,000 years old and has 29 clearly delimited carvings, although without any apparent logical 'relation'. Francesco d'Errico suggests that a pebble found in the 'Blombos' cave is proof of geometric thinking because it has seven parallel lines and thus the 50,000 to 70,000 year old object may represent the oldest known object with a 'design' [11]. Of course, these claims do not refute the hypothesis that the Ishango rod is the oldest mathematically significant object ever found. On the contrary, they turn the object into a less singular proof of 'mathematical awareness' in Africa, long before Egypt or Greece [4].

To summarize, in the past 50 years, the dating of the rod was settled and the mathematical arguments

Figure 2. The Ishango rod. © RBINS. Reprinted with permission.

concerning its purpose were whittled down from several mysterious interpretations to the simple explanation that the rod is but a simple mixed base tally stick – albeit, the oldest one. And thus, after half a century in a dusty drawer on the 19th floor of the Brussels' Royal Institute for Natural Sciences of Belgium, in 2001 the Ishango rod descended to the main hall of the associated museum.

However, Ishango itself had not yet revealed all of its secrets. On his death bed, de Heinzelin wrote a draft paper about a second carved Ishango rod that he had also found all those years ago [15]. During a conference in 2007 at the Royal Academy of Belgium, this second Ishango rod was unveiled. It received enormous attention in the press. News of it made the front page of the respected newspaper *Le Monde*, thus proving Ishango and mathematics could still make people dream. It should be noted that all the attention given by the media, including CNN, contributed towards convincing Belgian authorities to make the Ishango rod part of the permanent exposition of the Brussels' museum. After all, the Ishango rod was found in colonial times in the former Belgian Congo and Belgium's colonial past was not an overall success story, to say the least.

3. The 'artistic' concept

The year 2001 when the Ishango rod first went on display was also the year of the Belgian Presidency of the European Community and thus a year of 'new expectations'. The year 2001 is also associated with Stanley Kubrick's movie *2001, A Space Odyssey* [5]. Its opening scene is well known: a human ancestor throws a bone, his first discovery of a tool, into space where it rotates and changes into a space ship. Kubrick has often been regarded as visionary in his movies, and gradually over time the idea of realising one of his visions by actually carrying the Ishango rod into space was conceived as a tribute to the metaphor from *2001, A Space Odyssey* (see Figure 3).

A weightlessly floating bone in space would further iconify the well known opening sequence from the movie *2001: A Space Odyssey* as well as reinforce pop culture references to it such as the one that has

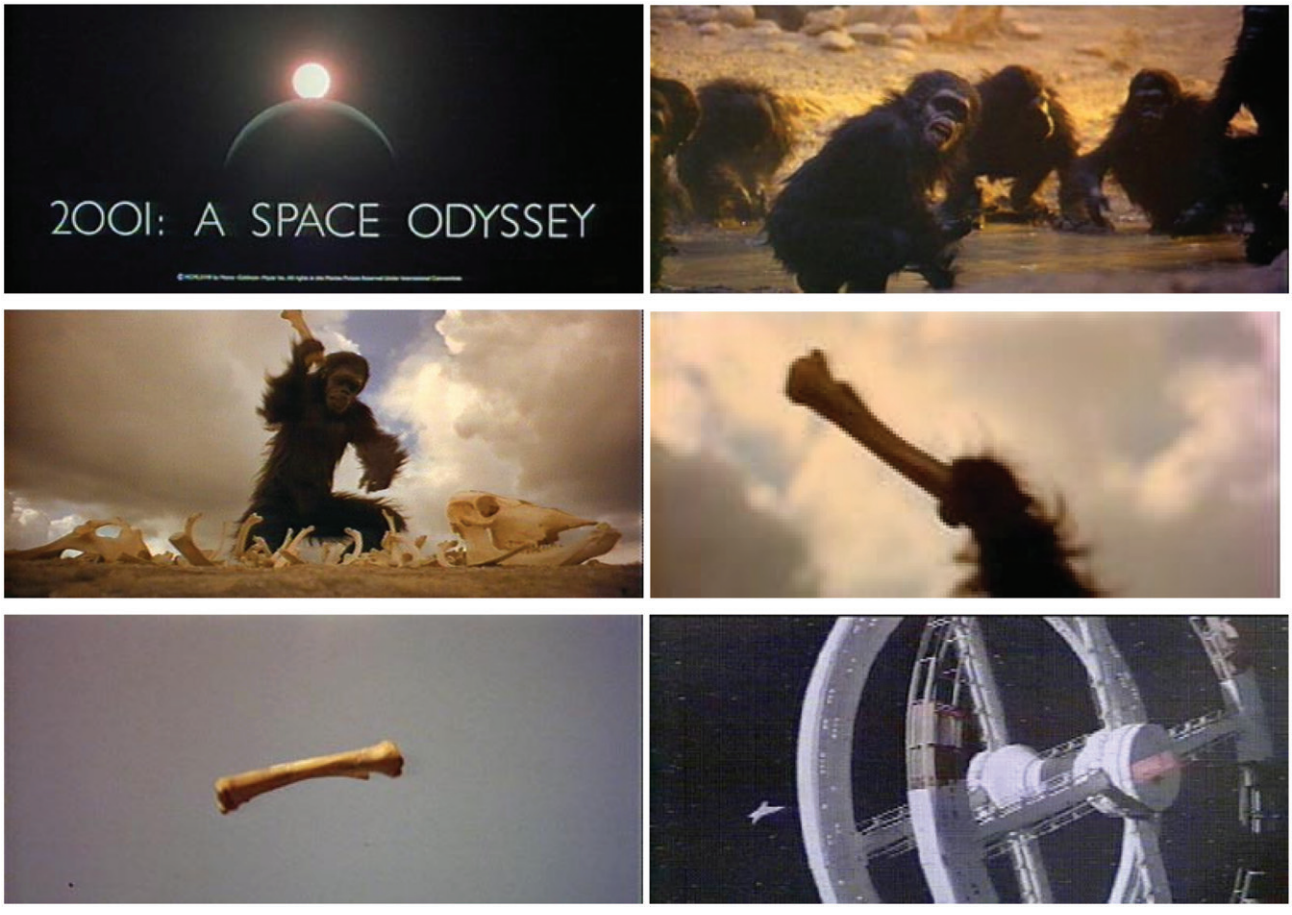

Figure 3. Images from *2001: A Space Odyssey* (see http://www.tiac.net/users/modemac/2001.html, http://www.palentir.net/2001). Reprinted with permission of the Turner Co.

famously appeared on *The Simpsons*, as well as others used in advertising. A single image is more compelling and direct than lengthy explanations. Furthermore, this can be realized at minimal cost because carrying into space an object only 10.2 cm long, the size of a small pencil, is sufficient for the intended objectives.

An artistic concept is subjective – 'beauty is in the eyes of the beholder'. Although not everyone might appreciate the impact of Kubrick's opening scene in *2001*, and thus may not agree with the idea of realizing it, the prospect of having an artefact in space for somewhat unusual reasons is not without precedent. For example, a work of art called 'The Fallen Astronaut' already exists on the moon. Coincidentally, it is also the work of a Belgian artist, Paul van Hoeydonck (see Figure 4). The original was brought to the moon by Apollo 15 but a copy can be admired in the Museum for Modern Art in the Belgian town of Ostend.

In the 1960s, Alexander Marshack was charged by NASA with providing historical and scientific background justifying the lunar programme for a broad audience. He stumbled upon the story of Ishango while questioning authorities in the administration and the scientific community about the reasons to undertake the space adventure. Later, he would become a first-rank archaeologist at Harvard University. In one of his early writings, *Roots of Civilization*, he described his quest as follows:

> I could not in my thoughts, while writing and searching for the meaning of man and the space program, separate Dr. Jerome Wiesner [...] or Yuri Gagarin and John Glenn [...] from the men who, thousands of years before, had hunted mammoth [...] and had painted the caves of Ice Age Europe.

Figure 4. 'The Fallen Astronaut', a Belgian artwork on the moon. © PMMK museum Oostende Belgium. Reprinted with permission.

Figure 5. ISShango: will the Ishango rod reach space? Drawing by D. Baise, Brussels, Belgium. Reprinted with permission.

Thus, as expressed by Marshack, carrying the Ishango rod into space should be understood as an international quest undoubtedly present in the minds of many.

4. Is the third time a charm?

The movie *2001: A Space Odyssey* is a grand opus in the history of motion pictures. The Ishango rod symbolizes the beginning of mathematical awareness 22,000 years ago. Nevertheless, both have to obey the obligatory rules of human decision making. In May 1995, V. Pletser was selected as Payload Specialist for the mission Spacelab LMS at the NASA-MSFC in Houston. As one of the main Ishango researchers (see above), he had planned to carry a replica of the Ishango rod into space with him in his personal luggage, but a last-minute setback of a political nature kept him on earth, thus aborting the first Ishango/Odyssey attempt.

The Belgian space mission of November 2002 was initially called 'Bel Odyssey' with a deliberate allusion to *Space Odyssey* (as well as to Bel-gium and the French word 'bel', for beautiful), but politics intervened again. The name was changed into 'OdISSea', while the 10 cm^3 reserved for the rod were replaced by a nun's embroidery, and instead of listening to the classical Strauss opus 'Also Sprach Zarathustra', the astronauts were treated to a song sung from earth by Helmut Lotti, Belgium's famous Elvis Presley imitator. Thus the second Ishango/Odyssey attempt turned out quite differently from that intended!

The movie *2001* had a sequel, entitled *2010: The Year We Make Contact* and this opens the door to a third Ishango/Odyssey attempt during the next 6-month Belgian space mission – a mission to the ISS being planned for May 2009. A group of French-speaking and Flemish-speaking scientists, Belgians and Afro-Belgians, Congolese and Rwandese scientists, archaeologists and mathematicians, astronauts and astronaut-candidates are attempting to realize a project they call 'ISShango'. Its chief objective is to produce a single powerful image: that of the Ishango rod floating weightlessly in the ISS. Of course, the inauguration of the first African artefact onboard the ISS calls for a respectable 'opening ceremony' during a TV broadcast from outer space. An astronaut would reveal the Ishango rod and allow it to float in the space station, and the fitting climax would occur when the object is put on display as a temporary 6-month 'exposition' in the space station, perhaps by being placed inside a hemisphere (a diameter of 11 cm suffices).

Belgian astronaut Frank De Winne submitted the ISShango proposal to the space agency authorities in January 2008. Thus, for the third time, the Ishango rod is facing consideration by the space administration. Hopefully mathematical persistence will be rewarded and this time it will go far enough, all the way into space (see Figure 5).

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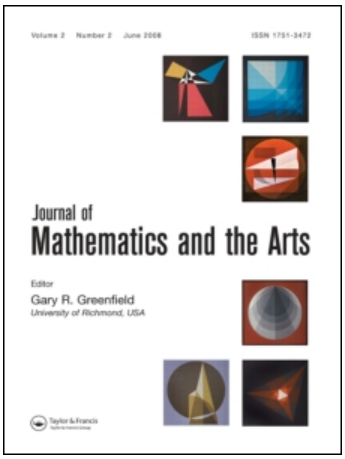

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